

HYPERSONIC ENGINE AIRPLANE INTEGRATION

NEW YORK UNIVERSITY
DIVISION OF APPLIED SCIENCE
AEROSPACE AND ENERGETICS LABORATORY
MERRICK AND STEWART AVENUES
WESTBURY, L.I.N.Y. 11590 NEW YORK

(NASA-CR-142093) HYPERSOINIC ENGINE AIRPLANE
INTEGRATION Progress Report, 1 Aug. 1974 -
1 Feb. 1975 (New York Univ.) 15 p

N75-71814

00/98 Unclas
08991

PROGRESS REPORT

August 1, 1974 through February 1, 1975

NASA GRANT NGR-33-016-131

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

FEBRUARY 1975

A summary of the research activities conducted at New York University Aerospace and Energetics Laboratory under the referenced Grant is presented here for the above period.

Research on this Grant is concerned with the design and analysis of an integrated scramjet engine. During this period New York University personnel concentrated on the design of a wind tunnel scramjet model that utilizes a heat conduction flame rather than a diffusion flame. The primary objective of this model is to demonstrate that a stable flow configuration in both the inlet and combustor could be obtained with this combustion mode. Secondary objectives of the model design are (1) to show that the combustion flow fields can be predicted by the method of viscous characteristics and (2) much shorter combustor lengths can be obtained with this combustion mode is opposed to those designed with diffusion flames. The model design also features a novel approach to pre-mixing the fuel in the inlet to reduce the engine length.

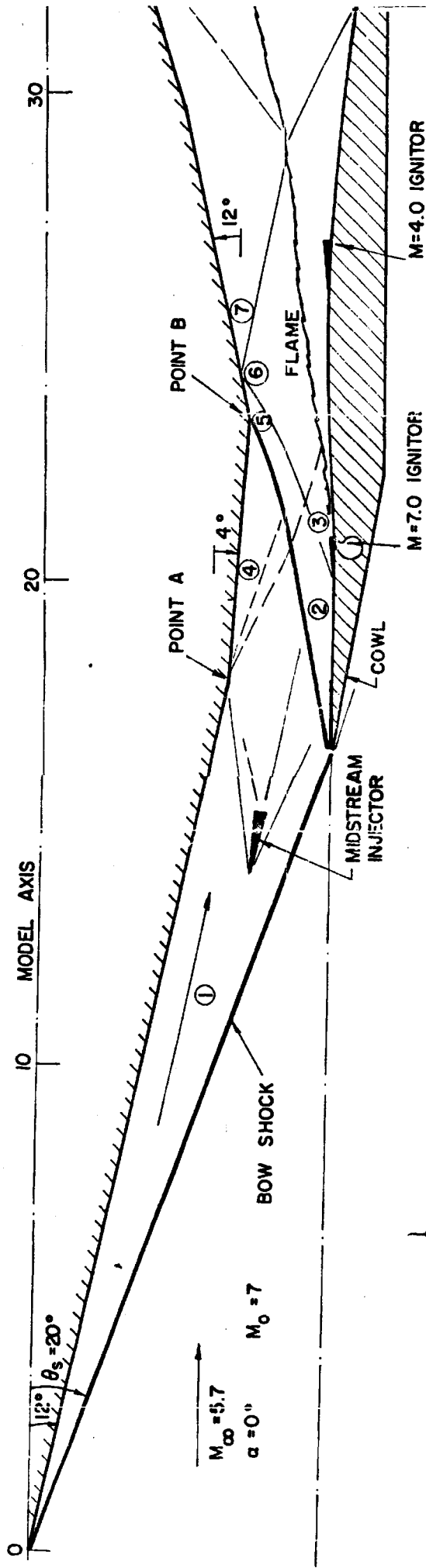
Several model configurations were tentatively investigated to satisfy the above objectives and wind tunnel constraints. The wave diagrams produced by the final configuration are shown in Figs. 1a and 1b. The fuel injectors location and injection conditions are presented in Figs. 2a and 2b respectively. These were located based on the results of several mixing calculations. The number of injectors was limited to five to facilitate the wind tunnel apparatus. The combustor wall contours are based on the analyses of several calculations of heat conduction flames accounting for self induced and lateral pressure gradients produced by the

combustion. The details of the model design, inlet aerodynamic flow analysis mixing analysis, influence of mixing on the inlet flow, and combustor flow analysis are presented in Ref. 1 for nominal flight and test conditions.

A rough draft of this report is presently being to the NASA contractor monitor. The analysis of the inlet and combustor flows at actual wind tunnel conditions will be conducted concurrently with the experimental program of General Applied Science Laboratory in the next reporting period.

REFERENCES

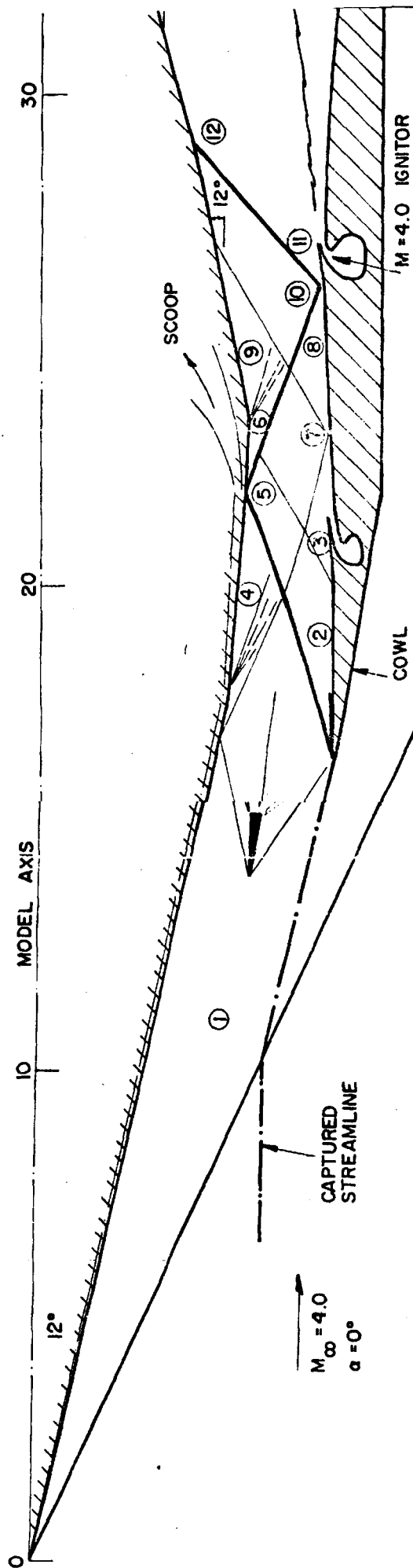
1. Agnone, A., "An Experimental Scramjet Model Design that Utilizes Heat Conduction Combustion," NYU Aerospace and Energetics Laboratory, Westbury, L.I.N.Y., January 1975. NYU-AA-



PT	∞	1	2	3	4	5	6	7	8
M	5.7	4.21	3.29	3.02	4.95	3.77	3.42		
P/P_∞	1.0	.7444	.645	.640	.744	.602	.596		
P/P_∞	1.0	4.267	13.1	19.7	1.71	6.21	4.80		
T/T_∞	1.0	1.647	2.36	2.66	1.27	1.95	2.23		
δ	0	12°	0	5°	4°	-8°	-12.0		
θ_s	-	20°	23.41°	21.25°		21.39	19.02		

Fig. 14 Wave Diagram at $M_\infty = 5.7$

3 B



PT	∞	1	2	3	4	5	6	7	8	9	10	11	12
M	4.0	3.14	2.52	2.30	3.62	2.86	2.237		3.30	3.0	2.636	1.9	
$P_0/P_{0\infty}$	1.0	.8325	.714	0.793	.8825	0.80	0.76		.77	.76	.73	0.65	
P/P_∞	1.0	2.946	7.20	9.95	1.48	4.0	9.0		5.50	3.04	13.8	26.0	
T/T_∞	1.0	1.411	1.96	2.04	1.16	1.59	2.03		1.32	1.5	1.75	2.44	
δ	0	12°	0	-5°	4.0°	-6.0°	4.0°		0°	-12°	12.0	-5°	
θ_s	-	241	23.23	27.42	16.04	25.3	30.41		17.14	-	27.3	37.43	

Fig. 1B Wave Diagram at $M_\infty = 4.0$

4

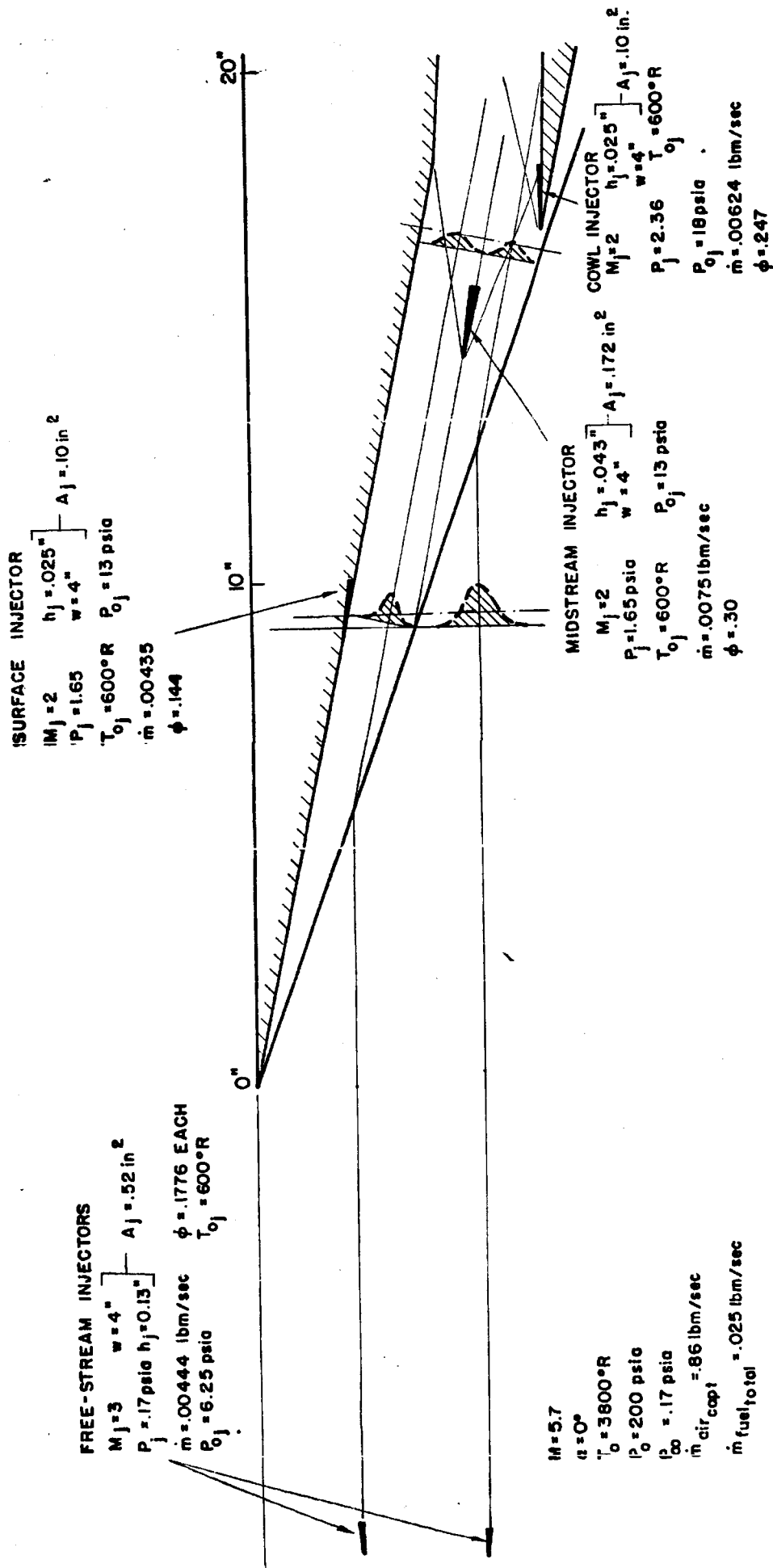


Fig. 4a. Fuel Injectors Locations and Injection Conditions - $M_\infty = 5.7$

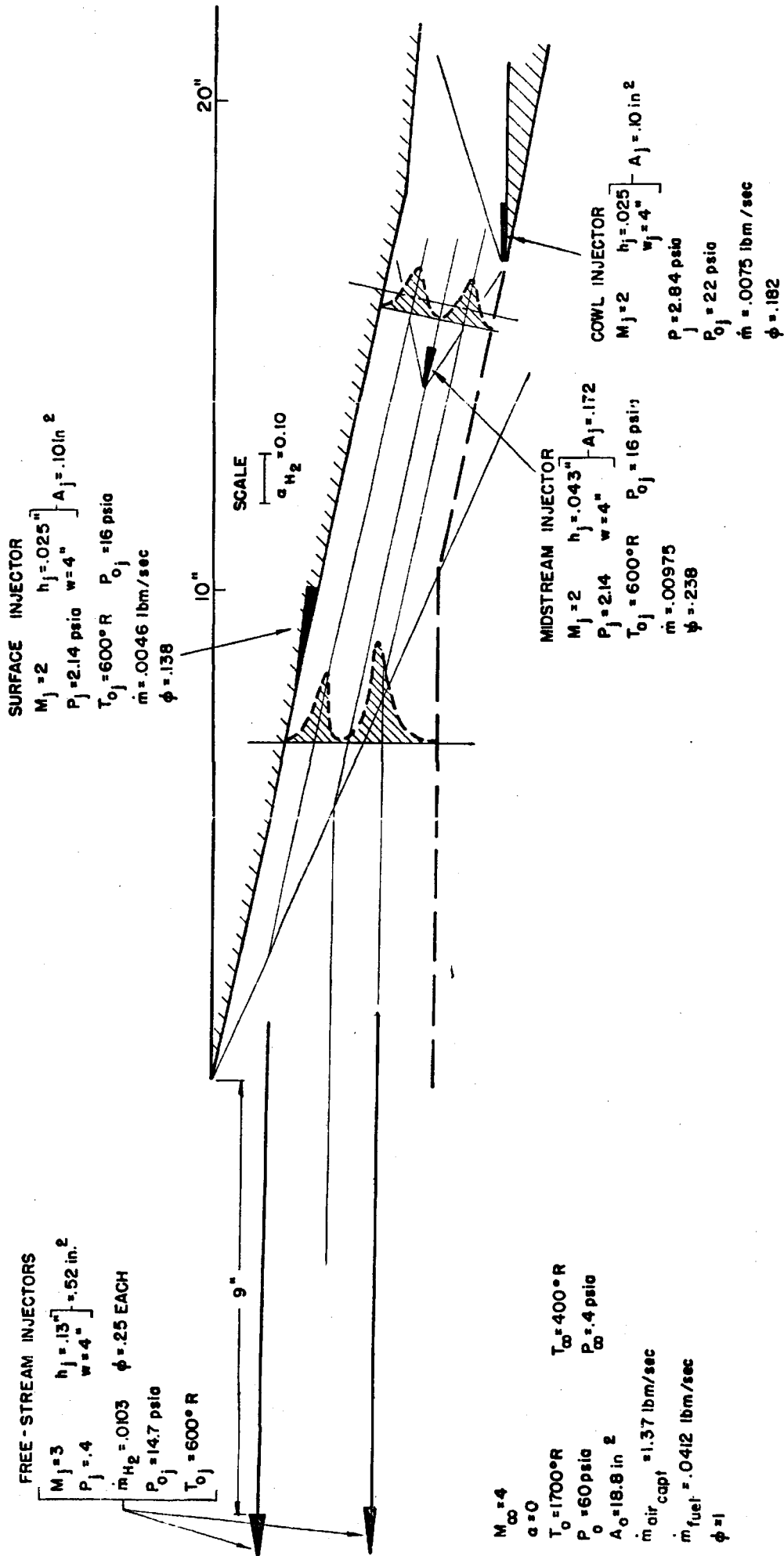
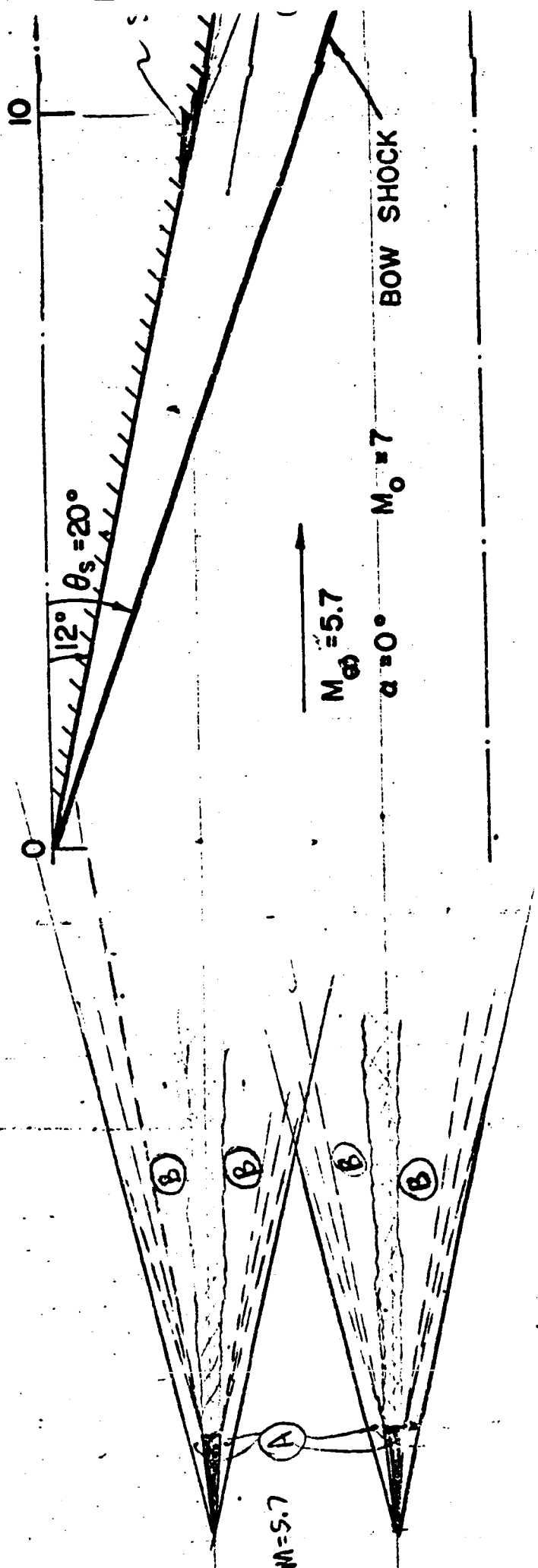


Fig. 4B Fuel Injectors Locations and Injection Conditions - $M_\infty = 4.0$

Fig SA WAVE DIAGRAM WITH FOUR INSTRUCTIONS INSTALLED



(A)	(B)	PT	∞	(1)	2	3	4	5
5.07	5.67	M	5.6	4.14	3.14	2.89	2.8	3
.970	.970	$P_0/P_{0\infty}$	.97	.73	.65	.64	.63	.72
1.946	.99	P/P_∞	1	4.18	13.3	19.6	22.9	2.47
1.22	1.001	T/T_∞	1	1.3	2.4	2.7	2.6	1.32
5°	0°	δ	0	12°	0.0	5°	5°	4°
13.66	11.38	θ_s	-	20.16	24.1	22.14	17.43	2

10 MODEL AXIS

20

30

SURFACE INJECTOR

①

②

③

④

⑤

⑥

⑦

⑧

⑨

⑩

⑪

⑫

⑬

⑭

⑮

⑯

⑰

⑱

⑲

⑳

㉑

㉒

㉓

㉔

㉕

㉖

㉗

㉘

㉙

㉚

㉛

㉜

㉝

㉞

㉟

㊱

㊲

㊳

㊴

㊵

㊶

㊷

㊸

㊹

㊺

㊻

㊼

㊽

㊾

㊿

0

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

26

27

28

29

30

31

32

33

34

35

36

37

38

39

40

41

42

43

44

45

46

47

48

49

50

51

52

53

54

55

56

57

58

59

60

61

62

63

64

65

66

67

68

69

70

71

72

73

74

75

76

77

78

79

80

81

82

83

84

85

86

87

88

89

90

91

92

93

94

95

96

97

98

99

100

101

102

103

104

105

106

107

108

109

110

111

112

113

114

115

116

117

118

119

120

121

122

123

124

125

126

127

128

129

130

131

132

133

134

135

136

137

138

139

140

141

142

143

144

145

146

147

148

149

150

151

152

153

154

155

156

157

158

159

160

161

162

163

164

165

166

167

168

169

170

171

172

173

174

175

176

177

178

179

180

181

182

183

184

185

186

187

188

189

190

191

192

193

194

195

196

197

198

199

200

201

202

203

204

205

206

207

208

209

210

211

212

213

214

215

216

217

218

219

220

221

222

223

224

225

226

227

228

229

230

231

232

233

234

235

236

237

238

239

240

241

242

243

244

245

246

247

248

249

250

251

252

253

254

255

256

257

258

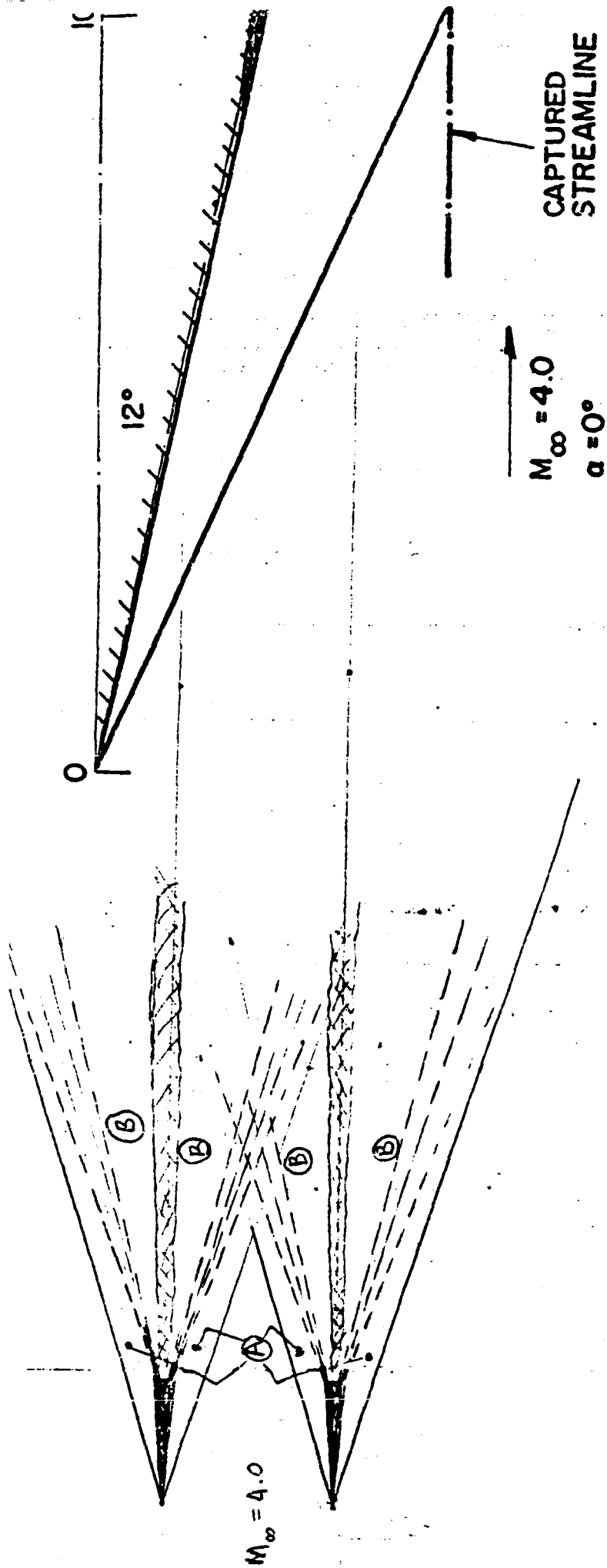


FIG 5B WAVE DIAGRAM WITH FUEL INJECTORS INSTALLED.

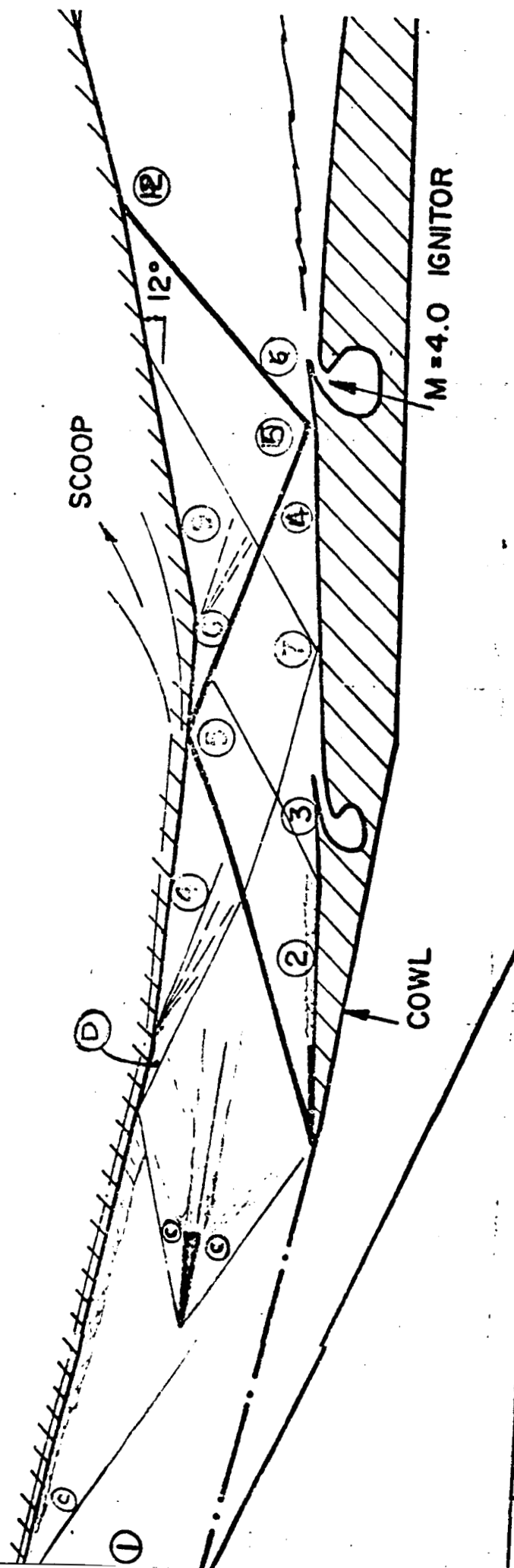
A	B	PT	∞	1	2	3	4	5
3.64	3.99	M	3.99	3.14	2.97	2.75	2.47	1.96
.98868	.988	$P_0/P_0\infty$	.988	.87	.788	.76	.67	.588
1.62	1.0	$P/P_0\infty$	.99	2.94	3.3	4.8	4.54	5.1
1.151	1.0	$T/T_0\infty$	1.005	1.41	1.4	1.56	1.58	1.86
$\pm 5^\circ$	0	δ	0	12°	7 1/2°	0	12°	17°
18.02	4.5°	$\theta_{g or \mu}$	-	24.1	23.13	30.5°	-	34.39

6-A

MODEL AXIS

20

30



6	6	1.36	.64	28.5
518				
570				
7				
24				

N O T I C E

THIS DOCUMENT HAS BEEN REPRODUCED FROM THE
BEST COPY FURNISHED US BY THE SPONSORING
AGENCY. ALTHOUGH IT IS RECOGNIZED THAT CER-
TAIN PORTIONS ARE ILLEGIBLE, IT IS BEING RE-
LEASED IN THE INTEREST OF MAKING AVAILABLE
AS MUCH INFORMATION AS POSSIBLE.